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Packaging and Waste in the Endoscopy Suite

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Abstract

Global warming is a great threat to life on our planet. Health care systems are high resource utilizers and contribute significantly to the problem. However, we can also be part of the solution as endoscopy services are the second waste producer in a hospital. Green endoscopy is a concept of implementing efficient strategies to minimize waste and to optimize utilization of equipment and supplies to maximize the benefits for the patient, the hospital, and our community. This manuscript aims to educate us on the problem and the cost to all of us as a whole and put into context the important part that endoscopic services have in energy utilization and waste generation. Finally, we suggest strategies, some low cost and high impacts, such as appropriate waste classification and disposal, some higher cost and high impact, such as water recycling and management as well as natural and LED lighting. We hope that we can generate enough momentum and enhance the discussion at the local, regional, national, and international levels about this challenge facing us and how we can be a unified force for positive change.

Keywords: Sustainable endoscopy; Endoscopy waste; Packaging in endoscopy.

Introduction

Global warming is an increasing threat to our planet and all its lifeforms. The consequences of the rise of Earth's temperature and change in its microclimates are experienced throughout the globe. The rising surface temperature and increased atmospheric carbon dioxide (CO_2) trends are alarming with recent atmospheric CO_2 near 400ppm up from the preindustrial CO_2 levels of <300 ppm.[1] In 2007, US healthcare contributed 8% of greenhouse gases (7150 million metric tons of carbon dioxide equivalent (MMTCO2Eq)) and 7% of total CO_2 emissions (6103 MMTCO2Eq) with an estimate of 54% associated with procurement of supplies and disposal of waste.[2] The Coronavirus Disease 2019 (COVID 19) pandemic caused a global recession and a decrease in toxic emissions but not enough to reverse the damage to our planet.[3–5]

Health Care Organizations require a significant amount of energy and resources to support their activities. Consequently, it is not surprising that they are an important contributor to greenhouse gas (GHG) emissions and resource utilization such as electricity, food, transportation, water, and waste generation.[5] Thus, there are ample opportunities for interventions that can decrease the production of GHG and allow for more efficient use of our resources leading to financial advantage to health care systems.

Physical waste production and disposal vary greatly in developed and developing nations. In the United States, waste is classified as regular trash and regulated medical waste (RMW), also known as "infectious waste" that is stored in red bags or sharp containers. The definition of RMW is any fibrous items saturated with blood or that blood would drip if squeezed or nonfibrous items that have enough blood present that they are dripping. It is estimated that RMW should represent less than 7% of total hospital waste.[6]

Endoscopy is one of the highest resource utilizers and waste producers in a hospital.[7] Medical waste elimination is 10-fold more costly to properly dispose of and it also requires storage in specific containers which are transported to a treatment facility, incinerated, and then taken to a landfill. These extra steps represent a significant addition to the environmental footprint in carbon emissions compared to the regular waste we normally produce. Gastroenterologists, surgeons, and primary care physicians who perform endoscopic procedures should be educated on the importance of appropriate resource

Abbreviations: CO_2, carbon dioxide; COVID 19, coronavirus disease 2019; GHG, greenhouse gas; GDP, gross domestic product; HACCP, hazard analysis and critical control points; LED, light-emitting diode; MMTCO2Eq, million metric tons of carbon dioxide equivalent; RMW, regulated medical waste

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Background

- Green endoscopy is the utilization of best practices to decrease waste and carbon footprint during endoscopy.

Findings

- Endoscopy generates a tremendous amount of waste and utilizes significant resources (number 2 in the hospital).
- Endoscopic services are predicted to increase in the future.

Implications for patient care

- Start with a quality improvement project and critical evaluation for opportunities in your unit.
- Low-risk/high-impact interventions include: monitoring inventory with a barcode system and correct disposal of waste in the appropriate bin (regular trash, regulated medical waste, and sharps).

utilization, inventory management, and waste allocation to maximize the benefits and decrease the carbon footprint of the procedures, a concept called "green endoscopy." In other words, green endoscopy is the concept of implementing efficient strategies to minimize waste, smart utilization of equipment and supplies to maximize the benefits for the patient, the hospital, and our community.[8] Green endoscopy has the potential to minimize the impact of Health Care Organizations' contributions to Global Warming while simultaneously strengthening their financial performance: an overall win for our planet.

Inventory of Single-Use Supplies Used Per Endoscopic Procedure

Similar to other household items that we are familiar with, there is a general "evolution" from reusable products to disposable single-use items. This was predominantly driven by the introduction of plastics which are much cheaper to produce but also are lighter in weight making them the ideal material to create reusable items. Endoscopic supplies are no exception. For example, in the Medical Procedure Unit at the University of Michigan, reusable biopsy forceps for endoscopic procedures, which costs $200 each, were replaced in 2002 with disposable forceps that cost $9. Therefore, it is no surprise that most of the endoscopic suites across the country were replacing their biopsy forceps with disposable ones. While this makes perfect economic sense, it is not hard to imagine that the amount of waste generated by these disposable items would become a significant problem if not managed properly.

One surprising contributor to waste comes from expired supplies that were misplaced due to a lack of inventory management and organization. In 2014, it was estimated that $93,000 of expired supplies were thrown out at our endoscopy unit. One of the reasons for the high number of expired supplies was that endoscopic supplies were being brought to the endoscopy room to ensure that they are available when needed; unused supplies, however, were left in the endoscopy room stashed away along with other general supplies. Some vendors will replace expired products while others donate them to World Relief. Commercial industries such as grocery stores encounter similar issues dealing with items that have a short half-life. Thus, keeping track of inventories in real-time will assure a well-stocked shelf with minimal waste due to expiring items.

Standard Vs Regulated Medical Wastes

It has been estimated that endoscopy generates about 3.09 kg of waste per bed per day, which is ranked third as the highest waste contributor in a hospital department.[7] The streams of waste that exit a procedure suite can be divided into standard waste or regulated medical waste (RMW) which not only differ in regards to the cost of disposal but also has a different impact on carbon footprint generation. A Japanese study that examined the amount of waste from endoscopy units from 3 hospitals found an average of 110.2-179.9 g of waste per case with 92.9% labeled as infectious waste[9] They applied Hazard Analysis and Critical Control Points (HACCP) used in the food industry to control food safety hazards in food factories or restaurants[10] and found 26% of the infectious waste to be non-infectious. Given more than half of the US healthcare GHG burden is attributable to the procurement of supplies and disposal of waste, a reduction of incorrectly disposed of non-infectious endoscopic waste as RMW by 26% will likely have a significant impact on the US healthcare GHG emissions which accounts for 9%-10% of the national GHG total burden.[11]

Challenges in Packaging and Waste Management

Over the last several decades, endoscopes and endoscopic supplies are slowly changing from multi-use to single-use devices. This particular change has obvious benefits in decreasing infection transmission risks; however, it increases cost, complexities of inventory management, and waste production. It remains controversial if the change from multi-use to single-use devices and scopes is an environmentally friendlier and more cost-effective strategy.[12–16]

Most endoscopic device companies are decreasing their inventory of multi-use devices and converting them to single-use ones, therefore the complexity of managing packages and their disposal is becoming an important issue. In regards to packaging, there is an ongoing effort to design packaging that is optimized for the particular device, being space-conscientious, assuring that its components originate from recycled materials, and the packaging is sent for recycling after opening. A recent study

showed a 13% reduction in waste and 55% cost saving when utilizing a "minimal custom pack" of disposable surgical supplies compared to the standard of care in wide-awake hand surgery.[17]

On an informal survey from several endoscopy units in North America, South America, Asia, and Europe (personal communication, unpublished), all have separate recycling bins for their packaging as well as bins for regular trash, regulated medical waste (RMW), and sharps (Figure 1). The biggest challenge in creating a sustainable endoscopy unit is the correct education of physicians, nurses, and technicians on the correct classification and disposal of different supplies used. In a survey performed with endoscopists, GI nurses, and technicians, 58% of staff and 65% of gastroenterologists disposed of endoscopic accessories incorrectly as RMW instead of regular trash. Moreover, 27% discarded endoscopic accessories as sharps, even though they are not classified as sharps and should not be handled in a sharp container.[18] This has tremendous financial implications as the cost of disposal of regular trash is approximately $0.03-$0.1 per pound as opposed to $0.2-$0.5 per pound for RMW and up to $2 per pound for sharps. Besides, disposal of RMW and sharps are more energy consuming and often produce toxic gases during the process (Incineration).[18] A study evaluating the impact of appropriate disposable practices demonstrated savings of over $700 million over 5 years for a health care system.[19] Another report from the United Kingdom showed that a 20% change in the correct classification of waste from RMW to regular trash could represent a savings of more than £4.7 million a year for the National Health Service (NHS).[20]

Physical Waste Production Across the International Market

There is limited data on waste produced by endoscopy services across the globe. A report from Italy estimated that gastroenterology/endoscopy was the second waste producer generating 0.5 kg/procedure, radiology produced 0.67 kg/procedure, and plastic surgery, 0.44 kg/procedure.[7]. On the other hand, the United Kingdom produced 195,734 tons of bagged waste for the 3 waste categories in 2015-2016 costing approximately £33.3 million: 59.4% was municipal waste, 32.8% was infectious waste (RMW in the US), and only 7.7% was classified as offensive waste.[20] The challenges in developing nations are even more daunting. Reports from Palestine demonstrated no segregation of waste with a high risk of contamination to the population.[21] In Iran, there is a high proportion of RMW (29%-51%) with poor segregation of the components.[22,23]

Another notable trend is the correlation between the percentage of Gross Domestic Product (GDP) spent in healthcare and the production of waste. There are, however, 2 notable exceptions. France has a much higher production of waste based on its GDP expenditure, while Germany has the lowest waste production per GDP expenditure in the world, highlighting its commitment to sustainability, proper waste assortment, and disposal.[7]

Opportunities for waste reduction in the endoscopy unit

Well established in the manufacturing industry, lean processes involve streamlining methods and maximizing efficiency. It has been shown to improve the efficiency of

Figure 1. Waste sorting in the endoscopy suite.

an endoscopic unit through training endoscopy personnel, observing patients, mapping the value stream, analyzing patient flow, designing and implementing new processes, and finally re-observing the process.[24] A similar process may be applied to reduce waste in the endoscopy unit by focusing on training the endoscopy personnel, observing patient behaviors, and designing and implementing new processes (Figure 2).

Quality improvement projects can be particularly helpful in identifying opportunities for improvement in each endoscopy unit as each challenge is unique. One may assess that the biggest opportunity may be in inventory. In such a case, the implementation of a barcode system, as performed by the endoscopy unit at the University of Michigan, makes more sense. In another situation, perhaps there is a significant amount of waste being disposed of in the "red bags." In this scenario, an education intervention has the highest yield to decrease the cost associated with unnecessary regulated medical waste utilization. We should start with a critical eye to our own enterprise, investigate the areas of opportunities, utilize the principles of green endoscopy to implement change, measure the impact, and re-evaluate.

Endoscopy personnel training and patient education

Agrawal et al found in a survey that the majority of endoscopic staff members are unaware of the higher cost of disposing RMW and inappropriately categorized endoscopic accessories as RMW thus placing them in red bags instead of in regular trash bins.[18] Thus, training endoscopic personnel on proper waste disposal to achieve a target % RMW is likely to have the most immediate impact on waste reduction. Also, closed-loop communication between the endoscopist and the other personnel is critical to ensure correct accessories are used while minimizing opened but unused ones. Also, consider bundled EGD/colonoscopy not only to minimize sedation risks but also to reduce waste including transportation associated GHG emissions; an additional consideration when doing bundled procedures is to perform EGD so that the same biopsy forceps can be reused for the colonoscopy (not the case when colonoscopy is performed first). Similarly, endoscopists' choice of intraprocedural accessory (eg, avoiding opening 2 polypectomy implements during a screening colonoscopy when one might suffice) are additional educational opportunities to reduce unnecessary endoscopy-associated medical waste.

Endoscopy unit management

Similar to achieving a lean endoscopy unit with a high-efficiency workflow to optimize resource utilization, unit management should design and implement processes to achieve the most desirable waste management outcome in the endoscopic suite. As an example, the current practice in the Medical Procedure Unit at University of Michigan Health Systems employs a barcode system that scans all items that are used in association with a particular procedure (eg, biopsy forceps, snares, variceal banding kits, hemostasis accessories, dilating balloons, endoscopic, ERCP wires, sphincterotomes, etc). Items that are associated with each type of procedure are made available at the start of the case, and items that are used will be scanned and those unused will be restocked. Implementing a similar trackable inventory system (ie, barcode system) has the obvious advantage of being able to achieve a tighter control on inventory to minimize expired supplies. Also, management leadership should consider the environmental impact of single-use items and evaluate waste management options according to their carbon footprint.

Partnership with Industry and Payers

Global warming affects us all. There are potential opportunities to partner with industry to streamline all aspects of endoscopy: supplies (multiple-use devices, recycling single-use ones), minimize waste in packaging, and endoscopes (multiple-use, recycling). In addition, payers could provide a financial incentive for units that can demonstrate that they are below a certain threshold

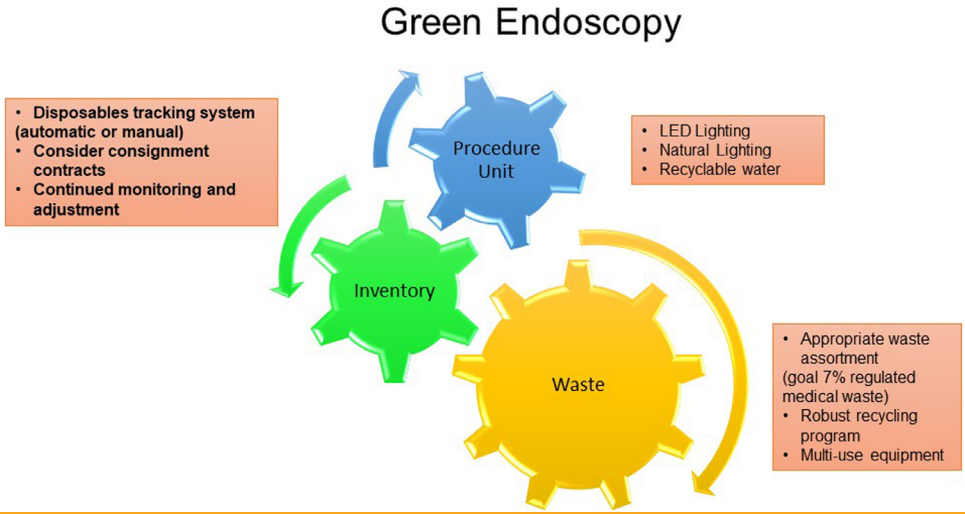

Figure 2. Green endoscopy waste reduction opportunities.

in the production of RWM (eg, a 2% bonus if a unit achieves the goal of restricting RWM to 15% a year).

Conclusions

Gastrointestinal endoscopy is a high resource utilization practice and the need for the endoscopic procedure is only growing to increase in the future. As such, we must take control of our practice and implement measures now to continue to provide endoscopic services to our patients in a responsible manner taking into consideration the finite resources of our planet and the important contribution that health care facilities have in generating greenhouse gas emission and global warming. Green endoscopy is an exciting new field of gastroenterology that will benefit from future research to assess which strategy provides the most benefit to patients, physicians, health care systems, and are most effective in decreasing waste and greenhouse emissions. This article describes strategies that can be implemented to achieve this goal while at the same time increasing profitability for the endoscopy units and health care systems in general.

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Ethical Statement
The study did not require the approval of an institutional review board.